Conclusion: The current study clearly reveals that OA-induced femoral qualitative and morphological changes of articular cartilage does not proceed simultaneously and equally in comparison to those of the confronting tibial and patellar articular cartilage in both tibio-femoral joint (TFJ) and patello-femoral joint (PFJ), respectively.

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DIAGNOSIS OF MORPHOLOGICAL INTERNAL KNEE DERANGEMENTS ASSOCIATED WITH OSTEOARTHRITIS ON MAGNETIC RESONANCE IMAGING SEQUENCES FOR QUANTITATIVE T2 AND T1RHO MAPPING OF ARTICULAR CARTILAGE COMPOSITION.

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Purpose: Novel quantitative magnetic resonance imaging (MRI) techniques for articular cartilage composition show promise for early detection of osteoarthritis (OA). However, large-scale application of quantitative MRI techniques in clinical OA research studies or in routine clinical patient care is hampered by long scan times. Implementation of quantitative MRI techniques may become more widespread if they can be applied as a replacement of routine morphological knee MRI pulse sequences rather than an extension of the MRI protocol. This study aimed to assess the diagnostic performance of a novel 3D fast spin-echo (FSE) T2 and T1rho sequence for quantitative mapping of articular cartilage composition for the detection of internal knee derangements. We focused on cruciate ligament and meniscal tears, which are among the most common internal knee derangements on MRI and are associated with (early) OA. We also determined the performance for diagnosis of bone marrow lesions and cartilage defects, which are morphological features of established OA.

Methods: 39 patients underwent routine clinical MRI of the knee on a 3T MRI scanner (Discovery MR750, GE Healthcare, Waukesha, WI) using a 16-channel flexible wrap-around coil (GEM Flex Coil, NeoCoil, Pewaukee, WI). The MRI protocol consisted of 5 routine 2D FSE clinical knee MRI pulse sequences in three orthogonal planes, and was extended with novel 3D pseudo-steady-state FSE sequences for the purpose of quantitative T2 and T1rho mapping of articular cartilage (sagittal plane, slice thickness 3mm, matrix 384x256, number of excitations 0.5, field of view 15 cm, scan time 6:49 minutes for T2 and 6:37 minutes for T1rho). Three separate de-identified MRI datasets with randomized patient order were created consisting of morphological, quantitative T2, and T1rho images. An experienced musculoskeletal radiologist evaluated all MRIs for anterior and posterior cruciate ligament (ACL and PCL) complete tears, and medial and lateral meniscal tears. Bone marrow lesions (BMLs) and cartilage defects were also assessed according to the semi-quantitative MRI Osteoarthritis Knee Score (MOAKS). In patients who subsequently underwent knee arthroscopy, the orthopaedic surgeon systematically assessed intra-articular pathology using the International Cartilage Repair Society (ICRS) scoring system. Diagnostic performance statistics were calculated for aforementioned morphological abnormalities on the T2 mapping and T1rho mapping sequence separately, only including lesions with a frequency of 5 more in our study population. Arthroscopic findings were used as reference standard for 23 patients that underwent arthroscopy, whereas for the other 16 patients we used routine morphological MRI as the reference.

Results: Only four lateral meniscal tears and no PCL tears were diagnosed. The 3D FSE T1rho sequence demonstrated good sensitivity and excellent specificity for the diagnosis for ACL tears and medial meniscal tears, and generally showed better diagnostic performance than the T2 mapping 3D FSE sequence (Table 1). For both sequences, sensitivity was poor for the detection of cartilage lesions, BMLs, and lateral meniscal tears. Illustrative examples of normal and abnormal internal knee structures are shown in Figure 1.

Conclusions: A 3D FSE T1rho sequence for quantitative mapping of articular cartilage composition shows good diagnostic performance for the anatomic diagnosis of ACL tears and medial meniscal tears. In MRI studies focused on these OA associated internal knee derangements, this sequence may replace routine clinical pulse sequences, enhancing scan time efficiency and potentially accelerating large-scale application in clinical OA research and routine clinical patient care. The poor diagnostic performance for BMLs and cartilage lesions may be less relevant with the availability of more sensitive indicators of OA status provided by these sequences, i.e. quantitative information on cartilage composition and quality. Examining quantitative T2 or T1rho information from these sequences along with the underlying morphologic images could enhance detection of cartilage and bone marrow lesions. We also expect that diagnostic performance would benefit from isotropic acquisition methods that enable multi-planar reconstructions.

Table 1
Diagnostic performance results

	T2		T1rho	
Lesion type (no. of lesions)	Sensitivity	Specificity	Sensitivity	Specificity
ACL tears (5)	0.75	0.91	0.80	0.97
Medial meniscal tears (11)	0.46	0.96	0.80	0.93
Bone marrow lesions (48)	0.52	0.99	0.51	0.99
Cartilage lesions (all) (63)	0.08	0.99	0.38	0.99
Cartilage lesions (full-thickness) (31)	0.10	0.99	0.45	0.99

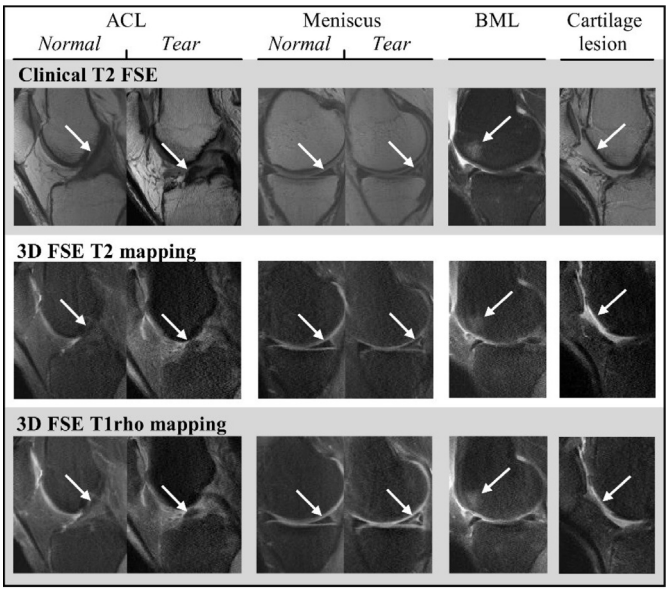

Fig. 1. *Examples of normal vs. abnormal knee structures:* Normal and torn anterior cruciate ligament (ACL) and meniscus, bone marrow lesions (BML) and cartilage lesions depicted on clinical T2 FSE as well as 3D FSE T2 and T1 rho mapping sequences (arrows).

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NON-INVASIVE SEMI-QUANTITATIVE AND QUANTITATIVE ULTRASONOGRAPHY FINDINGS IN KNEE OSTEOARTHRITIS: PRELIMINARY STUDY

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Purpose: Radiographic Kellgren-Lawrence (K-L) grading system is frequently used to assess knee osteoarthritic (OA) pathology. Recently it has been suggested that non-invasive semi-quantitative ultrasonography (US) might be suitable as the first-line screening tool with positive predictive value for articular cartilage (AC) changes in knee OA. The relationship between knee US and K-L grading has not been reported though. A quantitative measure, US roughness index (URI), has been earlier introduced to describe changes in AC surface from acquired US signals *in vitro*. However, it has never been applied to US images acquired non-invasively *in vivo*. In the present study, we compared semi-quantitative US grading of AC and osteophytes with the traditional radiographic K-L grading, as well as quantitative URI parameter of AC and subchondral bone (SB) with semi-quantitative US grading.

Methods: Healthy asymptomatic volunteers ($n = 21$, 8 men, 13 women) and patients with persistent knee pain symptoms ($n = 23$, 8 men, 15